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Inflation and Rate Base Valuation

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Abstract

Rate base research was conducted in the early days of the electric utility industry; however, the early studies were void of statistical rigor. In an important publication in 1962, Eiteman first brought strict statistical methods to bear in a study of the impact of public utility regulation on fifteen Bell Telephone Companies. After Eiteman's work, a number of additional statistical studies examined the rate base question.

Evidence indicates that regulators are feeling pressure from the courts to employ a fair value rate base in their deliberations; yet, the impact of such a change has not been unambiguously determined.

Using time series data, for a sample of firms from states which actually changed rate base methods since WW II, this study concludes that a change to fair value valuation will not automatically result in higher earnings for electric utility firms. Moreover, the results show that regulatory commissions frequently overcompensate or undercompensate utility firms for the effects of inflation whenever they establish the level of allowed earnings and prices.

INFLATION AND RATE BASE VALUATION

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I. INTRODUCTION

Valuation of public utility property for rate making purposes has been controversial since the beginning of the institution of public regulation. Even though much academic research and practical experience has evolved since utility commissions first became the formal regulators of public utility businesses, there is no consensus of academicians nor practitioners concerning the appropriate value of physical property used for providing service to customers. In public utility rate making, the value of this physical property, net of depreciation, is called the rate base.

An important question is how well do regulatory processes compensate for inflation. Hence, the rate base valuation issue is not of academic interest only; indeed, it has been said that the rate base is at the core of the rate determination process in practice.[1] The importance of rate base determination, in practice, is reflected in several recent cases before the Illinois Supreme Court. One particular case involved an appeal of a rate case which had been completed by the Illinois Commerce Commission.[2] Union Electric Co. was dissatisfied with the disposition of their request for rate increases and appealed the judgments of the Illinois Commerce Commission to the Illinois Supreme Court. The Court ruled that the Commerce Commission must use "fair value" in the rate making process.[3] The most interesting aspect of this case, for this study, is that Illinois had previously used a "fair value" basis for rate making but changed to "original cost" on March 13, 1973. This situation

reflects recent interest by the Courts and it also indicates, in the opinion of the Court and the utility company involved, that there would be significant differences in the result of a given rate case depending upon whether original cost or fair value rate base valuation is used in the proceedings.

There has been considerable regulatory energy and academic research devoted to examining the question of what constitutes the "correct" basis for valuation of the rate base of utility firms. Results of several previous studies show that there is statistically no earnings difference between firms regulated in original cost and fair value jurisdiction. These results seem to indicate that the recent ruling of the Illinois Supreme Court seems to be without sound basis in economic reality; a change in rate base methods would not change the level of realized earnings of utility firms.

The topic is important but results of past research have obviously not been convincing to regulators and the Court; consequently, further research on the performance effects of different rate base methods is useful and necessary.

This study attempts to answer two important questions. First, do rate base methods matter? That is, are there any important results caused by changes in regulatory regimes from fair value to original cost or vice versa. Second, if regulators do cause any important changes, do they just adequately compensate or over compensate the utility firms for changes taking place on the price level. The overall main purpose of this study is to determine whether methods of rate base valuation affect the earnings, prices and output of electric utility firms by using techniques and data designed to avoid some problems in other studies of rate base methods.

Generally, the results of this study reveal that there does not seem to be any systematic relationship between methods of rate base determination and profits or prices charged by electric utility firms. While there were instances where the results supported the proposition that fair value methods would yield higher profits and prices than original cost techniques, the results were scattered. The results show that regulatory commissions, of firms included in the sample, were usually either over compensating or under compensating for inflation occurring in the economy.

II. PREVIOUS STUDIES

The economic literature of rate base determination is extensive. Hays in 1913,[4] for example, presented a comparison of original cost and replacement cost rate base determination. In a 1924 study, Ruggles[5] carefully evaluated the "Fair Return" concept in utility regulation, and in 1926 Bonbright[6] examined the valuation of property as a basis for rate regulation. Since those early studies, there have been many other examinations of virtually every facet of the rate base problem; however, only four papers, discussed below, are of particular interest to this analysis.

In an important seminal paper in 1962, Eiteman examined the impact of public utility regulation on fifteen Bell Telephone Companies.[7] In examining the permitted and earned rates of return, Eiteman found that the original cost regulation jurisdictions have permitted the highest rates of return on rate bases and firms operating in reproduction cost jurisdictions have been permitted the lowest.[8] Similar results were reported by Hagerman and Ratchford.[9] Eiteman found, however, that the higher permitted rates had been only partially compensatory because in the 1950-59 period, "...actual rates of return to book value of securities (that is to original cost)...have been highest for companies in the reproduction-cost jurisdictions and lowest for the companies in the original cost jurisdictions."[10] Eiteman carefully explains that the results of his study apply only to the 15 Bell Telephone Companies in his sample.

Using data for 1961-1963, Pike found that the mean rate of return was 6.38 percent on net plant in original cost states and a 6.63 percent where other valuation methods were used.[11] Pike noted that the spread between earnings under the different valuation methods had narrowed and was <u>not</u> statistically significant.

Primeaux examined realized rates of return earned by 116 firms in 1967 and 124 firms in 1973.[12] The 1967 sample was composed of sixty-six electric utility firms from original cost jurisdictions, forty-two from fair value jurisdictions and eight from reproduction cost states. The 1973 sample consisted of seventy-three firms from original cost states, forty-three from fair value jurisdictions and eight regulated by reproduction cost methods.[13] The study employed analysis of variance techniques and the results revealed that, statistically, there was no difference in earnings of firms in the sample according to method of rate base determinations. That is, the three most commonly used methods of rate base determination resulted in firms earning approximately the same rates of return. The conclusions were the same for both the 1967 and the 1973 samples.

Rock raised several questions concerning the rate base classifications used in the Primeaux study.[14] Rock's approach caused the sample composition between original cost and fair value firms to change slightly. Rock also used analysis of variance and tested the results of Primeaux's study. He also expanded data to include 1974 and 1975. All but one of the reclassifications were disputed by Primeaux.[15] Nevertheless, even after considering all of his proposed reclassifications, Rock also concluded that rate base methods were unimportant, thereby confirming Primeaux's findings.[16]

Several questions may be raised about the previous studies which affect the quality of their results. First, book value of securities as used by Eiteman and net plant used by Pike, may not be satisfactory proxies for a rate base; if not, the results of their studies were affected by the nature of the proxies used for the rate base. Second, Eiteman acknowledged that the applicability of his conclusions must be limited to the 15 Bell Telephone firms included in his sample. Consequently, further study of electric utilities is justified. Third, the Primeaux and Rock studies involved analysis of variance as their statistical techniques and other uncontrolled variables could have affected the results of the statistical tests used. Fourth, all of the previous studies mentioned above involved cross section data. The nature of cross section data raises serious questions concerning the integrity of the results because of the lack of uniformity of procedures for computing rate bases by State Commissions. All states, for example, do not compute fair value in the same way.[17] The nature of the data used in this study tends to hold constant the technique used in applying a given rate base method.

All of the above questions and problems could have affected the results of the previous studies and they certainly indicate that further research is necessary to assess correctly the impact of rate base methods on rates of return realized by electric utility firms. Indeed, Ferguson (a practitioner in regulatory matters) recently explained how and why academic research is important in affecting the outcome of actual rate cases.[18] He argues that it is important to develop more accurate information and confirm research results to assure their validity because they will affect regultory decisions.[19]

III. THE THEORY

Conceptually, the rate making procedure is very straight forward. The regulators of public utility firms are charged with the responsibility of setting rates which will be high enough to permit the firm to earn a fair return on its investment but not so high as to yield an economic profit. The rate making equation is as follows:

$$\text{Cost of service} = RR = E + d + T + (V - D)R$$

where:

RR = revenue requirement of the firm

E = current operating expenses (excluding depreciation)

d = current depreciation expenses

T = current taxes

V = gross value of physical property

D = accrued depreciation

R = rate of return

$(V - D)$ = rate base

$(V - D)R$ = return amount.

In the process of a rate case, the firm is allowed to recover, through future rates charged for it's services, all of the current operating expenses incurred, including current depreciation and taxes. Moreover, as indicated in the above rate making equation, the firm is also allowed to include in the rates charged for it's services a component to cover $(V - D)R$. That is, the value of the rate base multiplied by a rate of return (this is the return amount). This is a key concept in the following discussion.

The appropriate values for E, d, T, D are rather straightforward. They essentially consist of expenses which the firm is allowed to recover from rate payers.[20] This is not to say that they are not the cause of occasional disputes. Instead, the point being made is that the determination of the rate base dominates all other problems in public utility regulation. This point is very clearly made by Phillips:

> Determination of the rate base...is one of the most important and most difficult problems confronting both the Commission and the regulated industries. No other conflict in the history of regulation has been subject to so much litigation.[21]

Original cost jurisdictions value the $(V - D)$ component in the equation at the value of the property when it was first installed in a public utility application. Fair value attempts to adjust the value of the $(V - D)$ component to that level which more correctly reflects its current value and reproduction cost attempts to adjust the value of the property to that level which would permit reproduction of the property. Since the rate base $(V - D)$, would be larger in fair value jurisdictions than in original cost states, the conventional view is that firms would realize a higher rate of return in fair value states.

In a world of no inflation, original cost and fair value would yield the same rate base value. The fundamental objective for establishing fair value rate base valuation is to compensate business firms for the change taking place in the value of money. Eli Clemens explained the reason for departures from original cost valuation.

> ...it tends to yield to investors an income of constant purchasing power. If prices rise and the value of money declines, the rate base will be increased and the utility investors will receive a greater return in monetary units of smaller purchasing power. On the other hand, a stable rate base tied to original cost would given investors enhanced real income in times of low prices and small real income when prices are higher.[22]

Price level changes are the real reason why fair value rate base valuation is advocated by some economists.

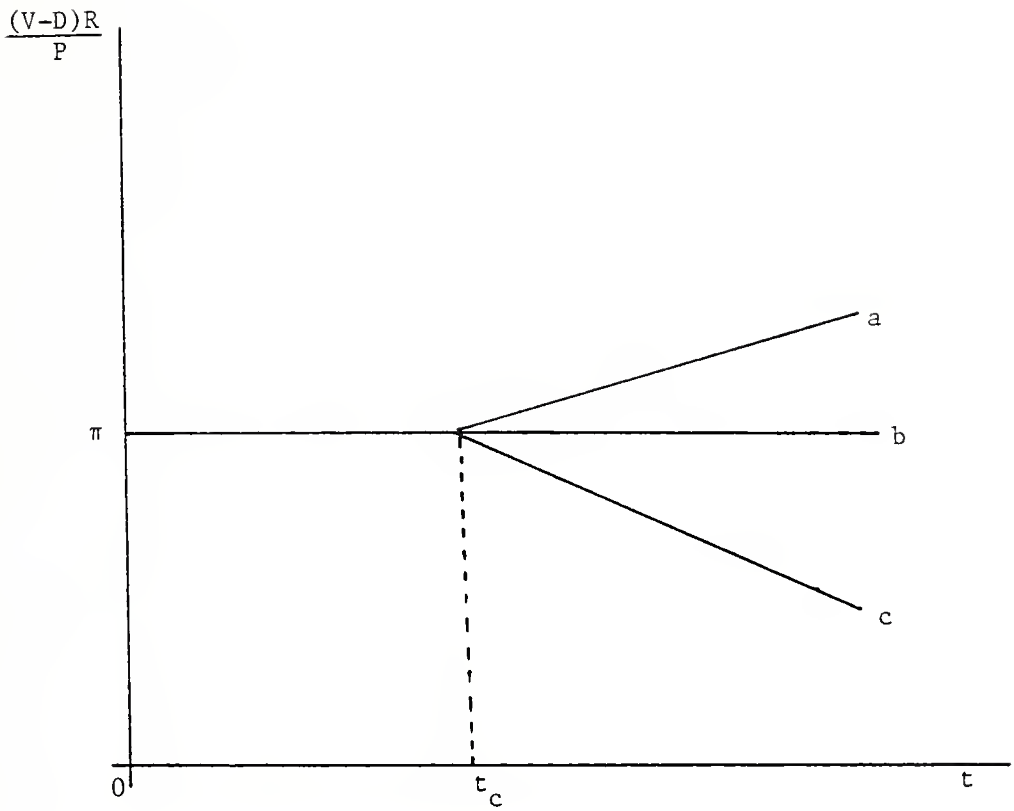
After the Commission determines the "cost of service" of the public utility firm, the next step in the rate making process is the determination of rates which the customers will pay for services. The Commission instructs the utility to prepare, for its consideration, the appropriate rate schedules to generate the allowed return.[23] This procedure, of course, involves assessments of different price elasticities in the different market segments. As mentioned earlier, in a world of no inflation, profits and prices would be identical for a given firm regardless of whether it is regulated by fair value or original cost rate base methods. When price level changes occur, however, the two methods yield different results. Fair value rate base methods would allow higher nominal return amounts to the utility than original cost rate base methods; consequently, higher nominal prices would also accompany fair value rate making. The actual effect of different rate base methods on _real_ realized return amounts and _real_ prices, however, is not obvious. The final result ultimately depends upon the success of the state regulatory commission in compensating the utility firm for inflation occurring in the economy. In actual practice, a firm may actually be overcompensated, undercompensated, or just compensated by the utility commission as it attempts to make adjustments, through time, to offset adverse effects of inflation on the real earnings of the utility firm.

If regulation is efficient in a fair value jurisdiction, experiencing no inflation, the real return amount earned by the utility would be constant; the fair value approach allows for adjustment because of inflation, so if no inflation occurred the real return amount would be constant through time, in real terms. This would occur because the utility commission has a real realized rate of return in mind which it considers to be reasonable and commissioners will establish that rate of return as the target in their deliberations. In figure 1, this result is shown by the path of π, indicated along b.

In a fair value situation, where inflation does exist, and the regulators are efficient and just offsetting the effects of the inflation, the path would still be flat as in the above discussion.

Whenever a state changes the method of rate base determination used by its regulatory commission, the result on a firm's real earnings (and real prices) cannot be unambiguously determined. For illustration, consider a state which regulates utility firms by original cost rate base determination. This case can be followed in Figure 1. The _real_ earnings for a firm would be π (assuming no inflation through time). Assume,

FIGURE 1



then, that the state changes rate base valuation from original cost to fair value at time t_0. At that time, the earnings path may continue to remain flat, if no inflation exists or if the state commission just compensates the firm for inflation. However, the utility commission may not just offset inflation. That is, the commission may overestimate the amount of adjustment necessary to compensate for the inflation; in this instance, earnings might follow path a, after the change in rate base method at t_c. On the other hand, the commission could underestimate the amount of adjustment necessary to offset inflation occurring in the economy; in this case, the earnings path after the change in rate base method might follow c in Figure 1.

In any of the cases discussed above, a reasonable assumption is that once the regulatory commission begins to use a formula to arrive at a fair value rate base it will probably continue to miscalculate over some period of time.

While the actual effects of the two different rate base methods on <u>real</u> earnings and prices is not obvious, it seems clear that original cost rate making would yield greater welfare benefits than fair value rate making. The reasons for this expectation are rather straight forward. The electric utility demand curve is downward sloping; consequently, lower consumption would take place under fair value than in original cost rate making. Since a larger consumers surplus would result from original cost pricing, consumer welfare would be enhanced by that valuation method.

The next section presents the procedure used to empirically test for the effects of different rate base methods on realized rates of return, prices and output of a unique sample of electric utility firms.

IV. PROCEDURE

Rather than use cross section data, as in previous studies, the decision was made to examine the effect of rate base methods on individual firms; therefore, the data consists of time series observations for a selected sample of firms which are unique.

The sample consists of those firms located in states which changed the method of rate base determination anytime during the period 1948-1978. Consequently, it is possible to examine the effect of changes in rate base valuation on individual firms.

The correct rate base classification used in each state was essential, so extreme care was taken to classify properly the firms which would be included in the sample. This precaution was considered necessary because there was some discrepancy in data sources concerning the classification of some states according to rate base method. The reported rate base method was validated by referring to six different sources to assure that the correct rate base method was used in this study.[24] The rate base classifications were examined through time to determine which states had changed method any time during the period since WWII. In a few cases, where there was ambiguity even after reviewing the references, state regulatory commissions were contacted to resolve remaining questions concerning rate base methods employed and whether or not changes had occurred. This review revealed that only four states had changed during the 1948-1978 time interval. Alabama changed from fair value to original cost in 1971, Illinois changed from fair value to original cost in 1973, North Carolina changed from original cost to fair value in 1964 and Missouri changed from original cost to fair value in 1958. The fact that two states changed to original cost and two changed from original cost during the sample period tends to enhance the value of the data.

All possible privately owned firms from each of the four states changing rate base method during the 1948-1978 period were included in the sample. Since publicly owned firms are largely free from state regulation, and are sometimes given different regulatory treatment from privately owned firms, it was decided to exclude them from the sample. The final sample consisted of one firm from Alabama, seven from Illinois, eight from Missouri, and four from North Carolina. Some firms were excluded from certain equations because they were only generating companies and did not have residential sales. A few firms were totally omitted because of insufficient data.

A separate set of equations was run for each firm in the sample; ordinary least squares multiple regression was the approach used to develop the equations. The procedure involved the use of five different reduced-form equations for assessing the effects of rate base methods on the earnings and prices of the individual firms in the sample.

A model of the demand and cost functions for firms was derived to obtain the reduced-form equations. This step was necessary to specify correctly the variables which would affect the performance of the dependent variables for the profit maximizing monopolists included in the sample.[25]

Sequentially, the econometric procedure was as follows: first, the data for all sample observations were included in the reduced form equations for each individual firm. Second, an equation was run for each firm, for each dependent variable, using only the long sub sample of data. For example, in the state of Illinois, the rate base method was fair value from 1948-1972 and original cost from 1973. Consequently the long sub sample, for firms in that state, would consist of the fair value observations which occurred during the 1948-1972 period. The long sub sample period differed from state to state, depending on when the rate base valuation change took place. The residuals computed from these regressions were used in subsequent steps in the analysis.

In the third step, the long sub sample regression was extrapolated (forward or backward, depending upon the situation) through the short sub sample time period and the mean error was computed for the short sub sample. Fourth, the standard error of forecast was computed for each short sub sample time period based on estimates for the long sub sample. Fifth, under the assumption that the standard error of forecasts are independent across time, the standard error of the mean forecast error was computed during the short sub sample period. Finally, the ratio of the mean error for the short sub sample to the standard error of the mean forecast error was used to compute a t ratio for the mean forecast error of the short sub sample. Each of the above six steps was followed for each dependent variable, for each firm in the sample.[26]

V. EMPIRICAL RESULTS

Realized Rates of Return Proxies

The reduced form equation for the rate base effects for the firm is as follows:

$$Y = B_1 + B_2LGNP + B_3LVA + B_4LPOP + B_5LPE + B_6LC + B_7LCAP + B_8T + B_9LGP + B_{10}IT + U$$

where: Y = dependent variable, explained below

LGNP = natural log of real GNP, in billions of dollars

LVA = natural log of real value added by manufacturing, in billions of dollars

LPOP = natural log of state population, in thousands of persons

LPE = natural log of real production expenses, in dollars

LC = natural log number of ultimate consumers, by number of consuming units

LCAP = natural log of the number of production plants operated by the firm

T = a time trend, a linear index where 1948 = 0, 1949 = 1, ... 1978 = 30

LGP = natural log real natural gas price, state averages, in thousands of dollars per trillion BTUs

IT = a profitability trend for the industry (net income of all electric utilities in the U.S., divided by operating revenue of all electric utility firms in the U.S.)

U = a random disturbance term.

The data and its sources are discussed in the appendix. In an attempt to develop a thorough analysis, two different realized rates of return dependent variables were used and different realized rates of return equations were run for each firm in the sample. Consequently, Y was defined in two different ways when examining the effect of rate base methods on realized earnings of the firms in the sample.

Log Y = natural log real firm operating income per thousand KWH sold to ultimate consumers.

Y = firm operating income as a percent of net plant.

The procedure involved in this section, and the study as a whole, generated a large number of regressions and variables so, similar to Jarrell, only partial information is reported in the tables.[27]

The next two sections present the empirical results for the two different dependent variables used as proxies for the realized rate of return earned by firms in the sample.

Real Firm Operating Income Per Thousand KWH Sold

Table 1 presents some statistics extracted from the individual firm equations with log real operating income per unit sold as the dependent variable. As mentioned earlier, throughout the analysis, the size of the long sub samples used to develop the firm equations in each state depended upon the year in which the rate base method was changed.

The t statistics indicate whether the change in rate base method affected real operating income. The table shows that the one firm in the sample from Alabama actually earned a higher real operating income per thousand KWH sold after the rate base method was changed from fair value to original cost. These results reveal that the utility commission overcompensated for inflationary effects in permitting the firm to earn higher real profits after method of rate base determination was changed to original cost.

Table 1 also shows that only one firm of the six from Illinois experienced lower real operating income per thousand kilowatt hours sold to ultimate consumers when that state changed from fair value to original cost; regulators have overcompensated for the effects of inflation in all other cases except for Illinois Power. In that case, the utility commission held real earnings constant and the firm earned the same real

TABLE 1

Equation, Log Real Electric Utility Operating Income
Per Unit Sold to Ultimate Consumer (000 KWH)

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
ALABAMA (Fair value 1948-1970; original cost 1971-1978)						
Alabama Power Company	.2132	.0402	5.30[a]	2.02	23	.9
ILLINOIS (Fair value 1948-1972; original cost 1973-1978)						
Central Illinois Light Company	.2288	.0742	3.08[a]	2.14	25	.9
Central Illinois Public Service Company	.3390	.0920	3.68[a]	1.54	25	.9
Commonwealth Edison Company	.1227	.0719	1.71[b]	1.98	25	.9
Illinois Power Company	.0336	.0549	0.61	1.49	25	.9
Mount Carmel Utility Company	.4137	.1131	3.66[a]	1.58	25	.9
Sherrard Power System	-.7104	.1428	-4.97[a]	2.03	25	.9
South Beloit Water, Gas and Electric Company	-	-	-	-	-	-
MISSOURI (original cost 1948-1957; fair value 1958-1978)						
Empire District Electric Company	-.4237	.0700	-6.05[a]	1.55	21	.9
Kansas City Power & Light Company	-.1217	.0306	-3.98[a]	3.04	21	.9
Missouri Edison Company	.3448	.1277	2.70[a]	2.22	21	.9
Missouri Power & Light Company	.1343	.1175	1.14	1.48	21	.9
Missouri Public Service Company	-.0858	.1598	-0.54	2.44	21	.9
Missouri Utility Company	.3399	.1417	2.40[b]	1.95	21	.8
St. Joseph Light & Power	-.7065	.0789	-8.95[a]	2.54	21	.9
Union Electric Company	-.9965	.1528	-6.52[a]	2.21	21	.8

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
NORTH CAROLINA (original cost 1948-1963; fair value 1964-1978)						
Carolina Power & Light Company	-.1893	.1681	-1.13	2.02	16	.98
Duke Power Company	1.086	.1956	5.55[a]	2.32	16	.90
Nantahala Power & Light Company	-3.609	.6182	-5.84[a]	2.98	16	.75
Yadkin, Inc.	5.216	2.0460	2.55[b]	3.01	16	.92

a significant at the 1 percent level
b significant at the 5 percent level
c significant at the 10 percent level

Source: Extracted from complete equations containing all variables in the model.

operating income per unit sold under both fair value and original cost regulation.

In the case of Missouri, backward extrapolation was used to compute the mean error and standard deviation of the forecast because the short sub sample occurs before the change in regulatory regimes. Table 1 reveals that two firms earned the same real operating income per kwh sold after the state of Missouri changed from original cost to fair value rate base valuation. Two firms earned higher real operating earnings under original cost valuation than under fair value rate making. The remaining five firms in the sample from Missouri all earned higher real rates of return under fair value rate making than under the previous original cost regimes. As in the previous cases, the state regulatory commission either undercompensated or overcompensated for inflation whenever real earnings were not identical under both regulatory regimes.

Realized real operating income effects were also mixed for electric utility firms in North Carolina after that state changed from original cost to fair value regulation. As shown in Table 1, one firm earned identical real operating income per kwh sold, while one firm earned lower real returns under the new fair value regime and two firms experienced higher real returns after the changes from original cost to fair value.

The above results show that the effects of changes in rate base methods were rather mixed. State regulatory commissions did not tend to hold real operating income of firms in their jurisdictions constant when rate base valuation methods were changed.

Net Income as a Percent of Net Plant

Table 2 presents some test statistics for changes in rate base methods in the equation with operating income as a percent of net plant as the dependent variable. As in the previous case, the results are inconsistent and scattered.

The one Alabama firm earned a lower percent of net plant under original cost than under fair value regulation.

Two Illinois firms earned identical net incomes as a percent of net plant under the original cost and fair value regulatory regimes; two firms, however, experienced lower net incomes as a percent of net plant after the state changed from fair value to original cost while three firms experienced opposite results.

The returns from Missouri seemed to be somewhat more consistent than those from Illinois. In that state, backward extrapolation into the short sub sample revealed that six firms experienced higher incomes as a percent of net plant under the previous original cost methods than under the new fair value regulation. Only two firms had experienced lower returns before the change to fair value than they experienced after the change.

The North Carolina experience was similarly mixed. Two firms experienced higher net income as a percent of net plant after that state changed from original cost to fair value and two firms experienced opposite results.

Overall, the effects of changes in rate base methods on net incomes as a percent of net plant were mixed. As in the discussion of real operating effects, state regulatory commissions seemed to be unsuccessful

TABLE 2

Equation Net Income as a Percent of Net Plant

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
ALABAMA (Fair value 1948-1970; original cost 1971-1978)						
Alabama Power Company	-.0067	.0027	-2.48[b]	2.22	23	.8
ILLINOIS (Fair value 1948-1972; original cost 1973-1978)						
Central Illinois Light Company	.0055	.0089	0.62	1.88	25	.5
Central Illinois Public Service Company	.0118	.0079	1.49[c]	1.56	25	.5
Commonwealth Edison Company	-.0002	.0059	-0.03	1.92	25	.9
Illinois Power Company	.0120	.0043	2.79[a]	2.08	25	.9
Mount Carmel Utility Company	.0320	.0091	3.52[a]	2.57	25	.8
Sherrard Power System	-.0219	.0079	-2.77[a]	2.17	25	.8
South Beloit Water, Gas and Electric Company	-.0965	.0086	-11.22[a]	1.86	25	.9
MISSOURI (original cost 1948-1957; fair value 1958-1978)						
Empire District Electric Company	.0199	.0065	3.06[a]	1.21	21	.5
Kansas City Power & Light Company	.0040	.0027	1.48[c]	1.82	21	.8
Missouri Edison Company	.0379	.0067	5.66[a]	2.61	21	.7
Missouri Power & Light Company	.0199	.0090	2.21[b]	1.62	21	.5
Missouri Public Service Company	.0653	.0206	3.17[a]	1.74	21	.7
Missouri Utility Company	.0169	.0085	1.99[b]	1.99	21	.7
St. Joseph Light & Power	-.0217	.0075	-2.89[a]	1.96	21	.7
Union Electric Company	-.0628	.0099	-6.34[a]	2.31	21	.9

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
NORTH CAROLINA (original cost 1948-1963; fair value 1964-1978)						
Carolina Power & Light Company	-.0200	.0067	-2.99[a]	2.40	16	.92
Duke Power Company	.0690	.0122	5.66[a]	2.11	16	.89
Nantahala Power & Light Company	-.1634	.0279	-5.86[a]	2.40	16	.84
Yadkin, Inc.	.0628	.0317	1.98[b]	2.73	16	.90

a significant at the 1 percent level
b significant at the 5 percent level
c significant at the 10 percent level

Source: Extracted from complete equations containing all variables in the model.

at holding real earnings constant and either overcompensated or undercompensated for the effects of inflation.

Price Effect Proxies

Two different price variables were used in the analysis to represent proxies for the pricing structure used by firms in the sample.[28] Individual price equations were run for each firm in the sample, for each of the two price dependent variables. Consequently, Y, was defined in two different ways when examining the effect of rate base methods on prices charged by firms in the sample.

log Y = natural log of the real price of 250 KWH sales of electricity.

log Y = natural log of the real price of 500 KWH sales of electricity.

The same method of deriving and estimating the reduced form equations was used for these two equations as was used in the realized rates of return equations.

As developed in the theory section, if regulatory commissions just compensate for inflation, real prices would be expected to be identical for a given firm in fair value and original cost rate base valuation as a given state changes from one to the other. Consequently, one would expect real prices to be raised or lowered if a state changed from one rate base method to the other only if the state commission makes imperfect adjustments. This section assesses the price effects of different rate base regulatory regimes by examining two different price proxies; the price of 250 KWH of residential electric service and the price of 500 KWH of residential electric service.

Tables 3 and 4 show that there were substantial differences among firms in the sample concerning the direction of real price movements

TABLE 3

Equation Log Real Price of 250 KWH of Residential Electricity

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
ALABAMA (Fair value 1948-1970; original cost 1971-1978)						
Alabama Power Company	.2564	.0251	10.22[a]	1.80	23	.98
ILLINOIS (Fair value 1948-1972; original cost 1973-1978)						
Central Illinois Light Company	.2142	.0401	5.34[a]	2.12	25	.94
Central Illinois Public Service Company	.0265	.0468	0.57	1.91	25	.97
Commonwealth Edison Company	-.1630	.0346	-4.71[a]	2.14	25	.97
Illinois Power Company	-.1177	.0226	-5.21[a]	2.53	25	.99
Mount Carmel Utility Company	.1182	.0081	14.59[a]	3.00	25	.99
South Beloit Water, Gas and Electric Company	.0516	.0358	1.44[c]	1.92	25	.99
MISSOURI (original cost 1948-1957; fair value 1958-1978)						
Empire District Electric Company	-.3106	.0681	-4.56[a]	0.89	21	.98
Kansas City Power & Light Company	-.1431	.0308	-4.65[a]	2.31	21	.98
Missouri Edison Company	.1971	.0387	5.09[a]	2.77	21	.97
Missouri Power & Light Company	-.2257	.0629	-3.59[a]	2.55	21	.95
Missouri Public Service Company	.8274	.2048	4.04[a]	2.47	21	.72
Missouri Utility Company	.3253	.0899	3.62[a]	1.99	21	.80
St. Joseph Light & Power	-.4467	.0603	-7.41[a]	2.41	21	.97
Union Electric Company	-.7224	.1432	-5.04[a]	2.04	21	.94

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
NORTH CAROLINA (original cost 1948-1963; fair value 1964-1978)						
Carolina Power & Light Company	.0827	.0136	6.08[a]	2.74	16	.9
Duke Power Company	.1574	.0240	6.56[a]	3.16	16	.9

a significant at the 1 percent level
b significant at the 5 percent level
c significant at the 10 percent level

Source: Extracted from complete equations containing all variables in the model.

TABLE 4

Equation Log Real Price 500 KWH of Residential Electricity

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
ALABAMA (Fair value 1948-1970; original cost 1971-1978)						
Alabama Power Company	.2089	.0195	10.71[a]	2.23	23	.98
ILLINOIS (Fair value 1948-1972; original cost 1973-1978)						
Central Illinois Light Company	.2324	.0313	7.42[a]	1.97	25	.98
Central Illinois Public Service Company	.0441	.0470	0.94	1.94	25	.97
Commonwealth Edison Company	-.1210	.0334	-3.62[a]	1.81	25	.98
Illinois Power Company	-.1101	.0539	-2.04[b]	2.29	25	.95
Mount Carmel Utility Company	.1859	.0116	16.03[a]	2.06	25	.99
South Beloit Water, Gas and Electric Company	.1156	.0409	2.83[a]	1.82	25	.98
MISSOURI (original cost 1948-1957; fair value 1958-1978)						
Empire District Electric Company	-.3339	.0381	-8.76[a]	1.23	21	.99
Kansas City Power & Light Company	-.1786	.0354	-5.05[a]	2.24	21	.98
Missouri Edison Company	.1071	.0391	2.74[a]	2.62	21	.97
Missouri Power & Light Company	-.2221	.0564	-3.94[a]	2.93	21	.97
Missouri Public Service Company	.3794	.1352	2.81[a]	2.48	21	.73
Missouri Utility Company	.4471	.1041	4.29[a]	2.73	21	.92
St. Joseph Light & Power	-.3836	.0538	-7.13[a]	3.08	21	.98
Union Electric Company	-.7594	.1745	-4.35[a]	1.69	21	.79

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
NORTH CAROLINA (original cost 1948-1963; fair value 1964-1978)						
Carolina Power & Light Company	.1254	.0136	9.22[a]	2.74	16	.9
Duke Power Company	.1994	.0265	7.52[a]	3.15	16	.9

a significant at the 1 percent level
b significant at the 5 percent level
c significant at the 10 percent level

Source: Extracted from complete equations containing all variables in the model.

after rate base methods were changed in their respective states. Yet, each individual firm in the sample experienced the same direction of movement in its 250 kwh and 500 kwh real prices after the change was made in its particular state. For this reason, Tables 3 and 4 will be discussed together.

The one Alabama firm in the sample established higher real prices after the state changed from fair value to original cost rate making.

One Illinois firm established identical real prices after that state changed from fair value to original cost to those which had been established prior to the change. Two firms, however, established lower real prices after the change in rate base method, while three firms set higher real prices.

In Missouri (using backward extrapolation) five firms established lower real prices before that state changed from original cost to fair value rate making higher real prices were set after the change. Three firms, however, established lower real prices after the change in regulatory regimes.

The two North Carolina firms in the sample both set higher real prices under fair value valuation than they had established under original cost regulation which existed before the change.

As in the case of the rate of return proxies, regulatory commissions seemed to be unable to just maintain real prices when their states changed from one rate base method to the other. Consequently, the result was that firms were required to establish rates which either over or under compensated for the effects of inflation when methods of rate base valuation were changed.

Consumer Welfare Proxy

This section examines the effect of different rate base valuation methods on consumer welfare. The proxy used for consumer welfare was per capita sales to ultimate consumers. As in previous analyses, individual equations were run for each firm in the sample. The dependent variable for these equations was defined as follows:

log Y = natural log of per capita electricity sold (total KWH sold to ultimate consumers, divided by state population).

The same derivation and estimation method was used for these reduced form equations as in the earlier realized rates of return and price equations.

According to the theory, reduced per capita consumption would occur under higher prices. Since block rates are used in this business, it was decided that per capita consumption is an important variable which should be examined to determine whether changes in method of rate base valuation ultimately resulted in restricted output and adversely affecting consumer welfare.

The welfare effects of changes in regulatory regimes are reflected, to some extent, by the information in Table 5.

In the case of Alabama, the one firm in the sample experienced larger sales per capita under fair value regulation than under original cost valuation.

All but one of the Illinois firms experienced smaller per capita sales under original cost valuation than under fair value regulation; the one exception experienced identical per capita consumption under both kinds of rate making.

TABLE 5

Equation Log Sales (000 KWH)/State Population (000)

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
ALABAMA (Fair value 1948-1970; original cost 1971-1978)						
Alabama Power Company	-.1145	.0209	-5.48[a]	1.74	23	.99
ILLINOIS (Fair value 1948-1972; original cost 1973-1978)						
Central Illinois Light Company	-.2167	.0749	-2.89[a]	1.94	25	.99
Central Illinois Public Service Company	-.2696	.0337	-8.00[a]	2.24	25	.99
Commonwealth Edison Company	-.0939	.0926	-1.01	1.42	25	.99
Illinois Power Company	-.0254	.0151	-1.68[c]	2.01	25	.99
Mount Carmel Utility Company	-.1799	.0729	-2.47[b]	2.77	25	.99
Sherrard Power System	-.2969	.0389	-7.63[a]	1.25	25	.99
South Beloit Water, Gas and Electric Company	-.2976	.0377	-7.89[a]	2.19	25	.99
MISSOURI (original cost 1948-1957; fair value 1958-1978)						
Empire District Electric Company	.4110	.0664	6.19[a]	1.27	21	.99
Kansas City Power & Light Company	-.0883	.0168	-5.26[a]	2.35	21	.99
Missouri Edison Company	.2468	.0732	3.37[a]	1.10	21	.99
Missouri Power & Light Company	-.0297	.0315	-0.94	1.90	21	.99
Missouri Public Service Company	-.3417	.0588	-5.81[a]	2.34	21	.99
Missouri Utility Company	-.1594	.0316	-5.04[a]	2.19	21	.99
St. Joseph Light & Power	-.0745	.0220	-3.39[a]	2.60	21	.99
Union Electric Company	-.0826	.0778	-1.06	2.41	21	.99

	Mean Error	Standard Deviation	t Value	D.W.	n	$\bar{R}^2$
NORTH CAROLINA (original cost 1948-1963; fair value 1964-1978)						
Carolina Power & Light Company	.1807	.0544	3.32[a]	2.40	16	.9
Duke Power Company	.0397	.0777	0.51	2.07	16	.9
Nantahala Power & Light Company	.3419	.1192	2.87[a]	3.38	16	.9
Yadkin, Inc.	.3289	.8988	0.37	2.68	16	.9

a significant at the 1 percent level
b significant at the 5 percent level
c significant at the 10 percent level

Source: Extracted from complete equations containing all variables in the model.

Two Missouri firms experienced no change in per capita sales of electricity after the rate base method was changed from original cost to fair value. The data show, however, that four firms experience higher per capita sales after the change to fair value rate making and two firms experienced lower per capita sales.

Two firms from North Carolina incurred unchanged per capita sales after that state changed from original cost to fair value valuation methods. Two firms in that state, however, experienced higher per capita sales after that state changed to fair value methods.

The above results fail to reflect any systematic pattern. It is not at all clear that one is able to claim any welfare benefits for one rate base method over the other. Of course, the weak result may be caused by the ineffectiveness of the proxy used to reflect welfare effects. It is very difficult, however, to establish a better measure, given the data which are available.

VI. CONCLUSIONS

The results of this study do not support the notion that firms fare better with respect to real realized earnings or real price levels under fair value instead of original cost rate base valuation. Neither can a case be made for enhanced consumer welfare because of higher consumption levels under original cost rate regulation. While there were scattered instances of the theory being upheld in the matter of profit, pricing, and sales these results were certainly not general.

Since the results of this study are based on individual firms experiencing changes in regulation, holding a large number of variables constant, the findings may be more meaningful than previous cross section studies. A previous cross sectional study explained that the lack of significance of rate base methods was affected by regulators allowing larger rates of return when rate base methods are downward bias.[29]

The results developed here clearly demonstrate that a state supreme court ruling requiring a state to employ fair value rate making will not necessarily mean that a firm in that state will be allowed the same rate of return on the larger rate base as that allowed on the smaller rate base and the firm will not necessarily earn a higher real profit.[30] The judgment that the fair value method will actually yield higher profit for the firm is without foundation in fact. Moreover, the ruling of the Illinois Supreme Court seems to be in conflict with the U.S. Supreme Court ruling in the Hope Natural Gas Co. (1942) case where the U.S. Supreme Court ruled that the end result in rate making was all that really mattered.[31] The Hope ruling means that regulatory commissions are not required to use any single valuation method or combination of methods. The process involved in getting to the end result is inconsequential.

Murray, who has had considerable experience on the practical side of utility regulation recently made the following statement:

> After observing a variety of commissions and their staffs at work, in both fair value and original cost jurisdictions there appears to be no procedural differences in their determination of rate of return... in actual practice there is not likely to be any operational differences in the activities behind closed doors of fair value and original cost regulatory commissions...there are two reasons for this, in my opinion. On the one hand, the fair value rate base has been operationally and legally discredited, and on the other hand, commissioners and commission staff, in viewing the regulatory procedural problems currently, do not conceptually distinguish between fair value and original cost...regardless of how the final order of a rate case is written, somewhere in

> the working papers and the actual record, available to commissioners as they reach a final decision, is a rate of return on an orignal cost rate base.[32]

Indeed, if the spirit of the Hope case permeates the state commissions, as Murray suggests, and they "manipulate" the rate of return to arrive at a "predetermined" return amount, this practice very likely helped to bring about the results presented in this analysis. From the Commission perspective, rate base methods do not really matter.

FOOTNOTES

*We thank Paul Newbold and James Johannes for comments which improved the final product.

[1]Walter J. Primeaux, Jr., "Rate Base Methods and Realized Rates of Return," Economic Inquiry, Vol. XVI, No. 1, 1978, p. 95.

[2]Union Electric Co. v. Illinois Commerce Commission (1978)--Ill 2d--381 N.E. 2d 1002; appeal: Union Electric Co. v. Illinois Commerce Commission (1979)--Ill. 2d--396 N.E. 2d 510; rehearing denied Nov. 30, 1979. A similar case was Illinois Bell Telephone Co. v. Illinois Commerce Commission (1978)--Ill 2d--381 N.E. 2d 999; in Allstate Insurance Co. vs. Helen F. Elkins (1979)--Ill 2d--396 N.E. 2d 528 Justice Ryan in his dissent referred to the 1979 case. "In that case we held that the previous construction...precluded us from considering the relative merits of the 'original cost' method as against the 'fair value' method ...we need not speculate which of the two methods we would accept 'were we writing on a clean slate'."

[3]Ibid.

[4]H. V. Hayes, "Original Cost Versus Replacement Cost as a Basis for Rate Regulation," The Quarterly Journal of Economics, August 1913, Vol. 27, pp. 613-29.

[5]C. O. Ruggles, "Problems of Public Utility Rate Regulation and Fair Return," The Journal of Political Economy, October 1924, Vol. 32, pp. 543-66.

[6]J. C. Bonbright, "Value of the Property as the Basis of Rate Regulation," Land Economics, July 1926, Vol. 2, pp. 276-81.

[7]D. K. Eiteman, "Interdependence of Utility Rate Base Type, Permitted Rate of Return, and Utility Earnings," Journal of Finance, March 1962, Vol. 17, pp. 38-52.

[8]Ibid., p. 39.

[9]Robert L. Hagerman and Brian T. Ratchford, "Some Determinants of Allowed Rates of Return on Equity to Electric Utilities," Bell Journal of Economics, Vol. 9, No. 1, Spring 1978, pp. 52-53.

[10]Ibid., p. 52

[11]J. Pike, "Residential Electric Rates and Regulations," The Quarterly Review of Economics and Business, Summer 1967, Vol. 7, pp. 45-52.

[12]Primeaux, op. cit., pp. 95-107.

[13]Ibid., p. 100.

[14]Steven M. Rock, "Rate Base Methods and Realized Rates of Return: Comment," Economic Inquiry, Vol. XVII, April 1979, pp. 297-299.

[15]Walter J. Primeaux, Jr., "Rate Base Methods and Realized Rates of Return: Reply," Economic Inquiry, Vol. XVII, April 1979, pp. 300-302.

[16]Rock, op. cit., p. 299.

[17]Primeaux (1978), op. cit., p. 105 discusses this problem. See also: C. F. Phillips, Jr., The Economics of Regulation, Revised Edition (Homewood: Richard D. Irwin, 1969), pp. 216-259.

[18]John S. Ferguson, "Risk Differentials and Rates of Return," Public Utility Fortnightly, June 5, 1980, pp. 6-7.

[19]Ibid.

[20]Paul J. Garfield and Wallace F. Lovejoy, Public Utility Economics, (Englewood Cliffs: Prentice-Hall, Inc., 1964), pp. 44-134 present detailed discussions of the various components of the rate making process.

[21]Phillips, op. cit., p. 216.

[22]Eli W. Clemens, Economics and Public Utilities, (New York: Appleton, Centry-Crofts, Inc., 1950), p. 152.

[23]This procedure is discussed in detail in Garfield and Lovejoy, op. cit.

[24]The information was obtained from U. S. Federal Power Commission, Federal and State Commission Jurisdiction and Regulation of Electric, Gas and Telephone Utilities (Washington, D.C.: various years); Eiteman, op. cit.; Pike, op. cit.; Phillips, op. cit.; U. S. Senate, State Utility Commissions Summary and Tabulation of Information Submitted by the Commissions. Document 56, 90th Cong., 1st sess., Washington, 1967; State of Arizona, Arizona Corporation Commission, Annual Report, June 1970.

[25]Several cost and demand studies influenced the development of the reduced form equation used in this study. The strongest influence was Gregg A. Jarrell, "The Demand For State Regulation of the Electric Utility Industry," The Journal of Law and Economics, Vol. XXI, October 1978, pp. 269-295.

[26]An alternative means for testing for a change in the reduced form equations coincident with the change of regulatory regimes would be the more conventional Chow tests. In those cases where the short subsample is less than the number of regressors this test is somewhat cumbersome, but not difficult to apply. The shortcoming of such tests,

from the perspective of this investigation is that the test fails to reveal whether the real rate of return (or prices) goes up or down in those cases where the hypothesis of stability across the regimes can be rejected. In this sense the test is not constructive. The major caution to note concerning the test applied here is the assumption of independence of the forecast errors over time. If the regression residuals are seriously autocorrelated, our estimates of the standard error of forecast are biased upwards, and consequently our test would be biased in favor of failing to reject the hypothesis of no change in structure. However, in most of the regressions reported below there does not appear to be a serious autocorrelation problem.

[27] Jarrell, op. cit., p. 286.

[28] See Paul L. Joskow, "Pricing Decisions of Regulated Firms: A Behavioral Approach," Bell Journal of Economics and Management Science, Vol. 4, No. 1, Spring 1973, pp. 118-140. This reference has examined prices of regulated firms relating price variability to cost changes. Regulatory Commission behavior concerning requested rate increases is also examined.

[29] Primeaux, op. cit., p. 105. Joskow explains, however, the determination of the allowed rate of return is a complex process affected by a number of variables. See: Paul L. Jaskow, "The Determination of the Allowed Rate of Return in a Formal Regulatory Hearing," Bell Journal of Economics and Mangement Science, Vol. 3, No. 2, Autumn 1972, pp. 632-644.

[30] Deloitte Haskins & Sells, Public Utilities Manual, USA, 1980, p. 14. This source makes the following comment concerning allowed rates of return on rate bases. "Rates of return allowed on a fair value basis are consistently lower than those allowed on original cost....This is not necessarily inequitable to the company because a lower rate...on the fair value base may result in the same return as a higher rate...on the original cost basis. If the higher rate were used on fair value, it could result in an unjustifiably high return to equity capital."

[31] Hope Natural Gas Co., Re, 44 PUR (NS) 1, 24 (1942).

[32] D. Murray, "Comment: The Rate Base as a Factor in Electric Utility Profits," Comment on a paper presented at the Social Science Association Meeting, March 28, 1974, Dallas, Texas.

APPENDIX

The Data and Sources

All data expressed in real terms were deflated by the implicit price deflator. The electric utility operating data were obtained from Statistics of Privately-Owned Electric Utilities in the United States (Washington, D.C.: U.S. Federal Power Commission, various years). Pricing data were obtained from Typical Electric Bills (Washington, D.C.: U.S. Federal Power Commission, various years). Population data were obtained from Statistical Abstract of the United States (Washington: U.S. Government Printing Office, various years). GNP data were obtained from the Economic Report of the President, 1980 (Washington: U.S. Government Printing Office, 1979). Value added by Manufacturing came from two sources: Historical Statistics of the United States, Colonial Times to 1970 (Washington: U.S. Government Printing Office, 1975), and Statistical Abstract of the United States. Natural gas prices were obtained from revenue and physical sales data found in Gas Facts (American Gas Association annual reports, various years).